Patient Testing – Forced Vital Capacity

Audience All personnel in the Pulmonary Function Clinic.

Purpose To describe the procedure for performing Forced Vital Capacity (FVC) on the Ultima PF and Ultima Cardio2 machines in the Pulmonary Function Clinic.

The Forced Vital Capacity measures the maximal volume of gas that can be expired as forcefully and rapidly as possible after a maximal inspiration to total lung capacity. This measurement will help determine if the patient has any obstructive or restrictive diseases of the airways.

Relative Contraindications

Due to increases in myocardial demand or changes in blood pressure

- Acute myocardial infarction within 1 wk
- Systemic hypotension or severe hypertension
- Significant atrial/ventricular arrhythmia
- Non-compensated heart failure
- Uncontrolled pulmonary hypertension
- Acute cor pulmonale
- Clinically unstable pulmonary embolism
- History of syncope related to forced expiration/cough

Due to increases in intracranial/intraocular pressure

- Cerebral aneurysm
- Brain surgery within 4 wk
- Recent concussion with continuing symptoms
- Eye surgery within 1 wk

Due to increases in sinus and middle ear pressures

- Sinus surgery or middle ear surgery or infection within 1 wk

Due to increases in intrathoracic and intraabdominal pressure

- Presence of pneumothorax
- Thoracic surgery within 4 wk
- Abdominal surgery within 4 wk
- Late-term pregnancy

Infection control issues

- Active or suspected transmissible respiratory or systemic infection, including tuberculosis
- Physical conditions predisposing to transmission of infections, such as hemoptysis, significant secretions, or oral lesions or oral bleeding

Spirometry should be discontinued if the patient experiences pain during the maneuver. Relative contraindications do not preclude spirometry but should be considered when ordering spirometry. If Therapist reveals any contraindications

upon arrival of the patient, the ordering physician, rotating Pulmonary Fellow or Medical Director maybe contacted for advisement.

Procedure The following is the correct procedure for performing a Forced Vital Capacity on a patient:

- Before beginning the test, zero the pneumotach by clicking the Zero Flow button. There must be no flow through the pneumotach during this procedure.
- Click the FVC tab. The FVC Data Collection screen appears.
- Place nose clips on the patient.
- Tell the patient to breathe normally through the pneumotach. If you have the Keystroke to Start Test option turned on (default), press the spacebar to begin data collection. If not, breathing on the system starts the testing procedure and begins data collection. The patient's breathing efforts are immediately displayed on the screen. Observe the patient's tidal breathing until the patient is comfortable.
- Instruct the patient to inspire fully.
- Instruct the patient to exhale as rapidly, forcefully, and completely as possible.
- Instruct the patient to inspire fully, as rapidly as possible.
- Press the spacebar or click the Stop button to end the effort.
- Instruct the patient to return to normal breathing. The data and graph are displayed immediately.
- Repeat until consistent, reproducible results are obtained.
- ATS guidelines state if there is <.025L change in volume for at least 1 sec (plateau), that maneuvers are acceptable.
- A minimum of three maneuvers should be performed with a maximum of 8 maneuvers.

Test Acceptability Requirements for Adults and for Children

	Required for Acceptability		Required for Usability	
Acceptability and Usability Criterion	**FEV1**	**FVC**	**FEV1**	**FVC**
Must have BEV <5% of FVC or 0.100 L, whichever is greater	Yes	Yes	Yes	Yes
Must have no evidence of a faulty zero-flow setting	Yes	Yes	Yes	Yes
Must have no cough in the first second of expiration*	Yes	No	Yes	No
Must have no glottic closure in the first second of expiration*	Yes	Yes	Yes	Yes
Must have no glottic closure after 1 s of expiration	No	Yes	No	No
Must achieve one of these three EOFE indicators:	No	Yes	No	No
1. Expiratory plateau (<0.025 L in the last 1 s of expiration)				
2. Expiratory time >15 s				
3. FVC is within the repeatability tolerance of or is greater thanthe largest prior observed FVC†				
Must have no evidence of obstructed mouthpiece or spirometer	Yes	Yes	No	No
Must have no evidence of a leak	Yes	Yes	No	No
If the maximal inspiration after EOFE is greater than FVC, then FIVC2FVC must be <0.100 L or 5% of FVC, whichever isgreater‡	Yes	Yes	No	No

Repeatability criteria (applied to acceptable FVC and FEV1 values)

Age .6 yr: The difference between the two largest FVC values must be <0.150 L, and the difference between the two largest FEV1 values must be <0.150 L
Age <6 yr: The difference between the two largest FVC values must be <0.100 L or 10% of the highest value, whichever is greater, and the difference between the two largest FEV1 values must be <0.100 L or 10% of the highest value, whichever is greater

Definition of abbreviations: BEV = back-extrapolated volume; EOFE = end of forced expiration; FEV0.75 = forced expiratory volume in the first 0.75 seconds; FIVC = forced inspiratory VC.
The grading system (Table 10) will inform the interpreter if values are reported from usable maneuvers not meeting all acceptability criteria.
*For children aged 6 years or younger, must have at least 0.75 seconds of expiration without glottic closure or cough for acceptable or usable measurement of FEV0.75.
†Occurs when the patient cannot expire long enough to achieve a plateau (e.g., children with high elastic recoil or patients with restrictive lung disease) or when the patient inspires or comes off the mouthpiece before a plateau. For within-maneuver acceptability, the FVC must be greater than or within the repeatability tolerance of the largest FVC observed before this maneuver within the current prebronchodilator or the current post-bronchodilator testing set.
‡Although the performance of a maximal forced inspiration is strongly recommended, its absence does not preclude a maneuver from being judged acceptable, unless extrathoracic obstruction is specifically being investigated.

Quality Categories for FVC or FEV1, in Adults and Children per ATS guidelines:

Grade	Number of Measurements	Repeatability: Age >6 yr	Repeatability: Age <6 yr*
A	>3 acceptable	Within 0.150 L	Within 0.100 L*
B	2 acceptable	Within 0.150 L	Within 0.100 L*
C	>2 acceptable	Within 0.200 L	Within 0.150 L*
D	>2 acceptable	Within 0.250 L	Within 0.200 L*
E	>2 acceptable	> .0.250 L	>0.200 L*
	OR 1 acceptable	N/A	N/A
U	0 acceptable AND >1 usable	N/A	N/A
F	0 acceptable and 0 usable	N/A	N/A

Definition of abbreviation: N/A = not applicable.
The repeatability grade is determined for the set of prebronchodilator maneuvers and the set of post-bronchodilator maneuvers separately. The repeatability criteria are applied to the differences between the two largest FVC values and the two largest FEV1 values. Grade U indicates that only usable but not acceptable measurements were obtained. *Although some maneuvers may be acceptable or usable at grading levels lower than A, the overriding goal of the operator must be to always achieve the best possible testing quality for each patient.*
*Or 10% of the highest value, whichever is greater; applies for age 6 years or younger only.

Therapist will determine overall grade for spirometry to include both FVC and FEV1 and will report in the comment section of the PFT Report.

Criteria for Bronchodilator

The criteria for performing a post bronchodilator study are as follows:

1. FEV1/ FVC ratio is < / = LLN.
2. Order states physicians want a post bronchodilator study.

3. Unit dose Albuterol 2.5mg/3ccNS will be used as standard bronchodilator for all patients. Patients that have an "allergy" may bring their own inhaler. The ordering physician may also request and prescribe another medication to be administered and therapist may obtain from pharmacy.

Low Grade Reporting

Patients that have a low grade FVC (spirometry), can be referred to have Impulse Oscilliometry (IOS). Therapist will send email to Pulmonary Fellow (on-rotation) for orders to be written for IOS if patient is from pulmonary physicians. Otherwise, fellow will make recommendation on review and ordering physician may choose to order IOS at their discretion.

This form documents the approval and history of the policies and procedures for the Pulmonary Function Laboratory. The Medical Director signs all policies verifying initial approval. Annually thereafter, the Director and/or designee may approve reviews and revisions.

Date	Approved by:	Signature
11/07	**V. Cardenas, MD** **Medical Director Pulmonary Laboratory**	
6/09	**V. Cardenas, MD** **No changes to the policy**	
7/10	**V. Cardenas, MD** **No changes to the policy**	
2/12	**A. Duarte, MD** **Medical Director Pulmonary Laboratory** **No changes to the policy**	
8/16	**A. Duarte, MD** **Medical Director Pulmonary Laboratory** **No changes to the policy**	
12/17	**A. Duarte, MD** **Medical Director Pulmonary Laboratory** **Changes to the policy**	
8/19	**A. Duarte, MD** **Medical Director Pulmonary Laboratory** **Changes to the policy**	
12/21	**A. Duarte, MD** **Medical Director Pulmonary Laboratory** **Changes to the policy**	
8/23	**A. Duarte, MD** **Medical Director Pulmonary Laboratory** **No changes to the policy**	